

High Temperature Materials Laboratory

Non-contact Weld Inspection in Ford Chicago Assembly Plant

Background

To reduce the overall weight of automobiles, U.S. car designers use steel sheets that have been stamped and welded in various parts of the body structure. In fact, most structural components in vehicles are held together by either resistance spot welds (RSWs) or laser welds (LWs). A survey by the U.S. Council for Automotive Research (USCAR) Nondestructive Evaluation (NDE) committee indicated that there is currently no in-line, nondestructive, weld inspection technology used by U.S. vehicle manufacturers.

Many of the current NDE techniques are post mortem. A labor-intensive, manual teardown inspection is performed every shift to determine weld quality, and in many cases, there can be a significant delay from the time a weld is produced to the time the same weld is inspected. For high-volume auto assembly production, the delay between welding and inspection could result in hundreds or even thousands of out-of-tolerance

welded parts being made before detection.

In addition, most of these techniques are contact methods. These have proven difficult to implement, and automakers have realized the importance in developing a reliable, non-contact NDE weld inspection technique. Such a technique would be beneficial by improving inspection reliability and efficiency.

HTML's Thermography and Thermophysical Properties User Center houses state-of-the-art infrared (IR) cameras that can take hundreds of images per second with a temperature resolution of just over one hundredth of a degree. The instant imaging results in temperature maps that can produce visual results of any heat-related process. Even more important for this project, infrared imaging can detect the thermal radiation of an object in a non-contact fashion.

When two metal sheets are joined by a weld (lap joint), the weld provides a heat conduction path from one sheet to another.

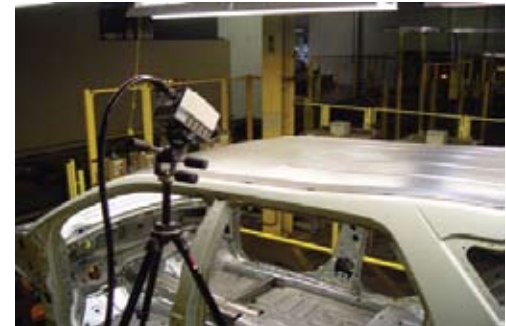


Figure 1. Set-up of an infrared imaging system for laser weld inspection at the Ford assembly line.

Benefits

- Reduced number of labor-intensive tear-down inspections.
- Improved quality control and inspection reliability.
- Potential real-time monitoring of the laser weld process.



Based on this fact, IR imaging can be used to inspect welds. Two primary methods have been used for weld inspections: heat sink and heat leak. For the Ford project, the heat leak method was used for both RSWs and LWs.

Technology

The IR camera is a portable system and can be operated from a laptop computer. The non-contact feature made it possible to conduct testing at the assembly plant without interrupting or interfering with the production process.

In addition, IR imaging provided a potential for real time monitoring of the laser weld process. It has already been demonstrated at the Oak Ridge National Laboratory (ORNL) that the IR camera can capture defects during the welding process. The welding heat and temperature distribution can then be used to monitor and control the process.

In the Ford project, 12 vehicles were inspected within a 2-hour period for LWs. The IR imaging system confirmed that one particular weld stitch was having quality problems. Some potential problem areas for spot welds were identified. Some “cold” welds were found on areas when no heat was coming through after the opposite side was heated with hot air. The IR imaging system was able to identify a consistent lack-of-fusion weld in multiple vehicles.

Status

Further work on the IR imaging system is ongoing. ORNL is working closely with U.S. auto manufacturers to ensure that the R&D of this technology is closely aligned with their needs. This will provide a clear path to commercialization in the future.



Figure 2. IR image of four welds before heating.

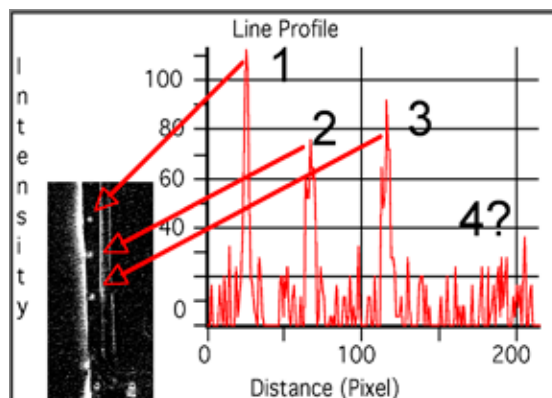


Figure 3. Heat came through three of the four welds, indicating lack of fusion on the fourth.

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